



Implementation of Geospatial Product Virtualization in Grid Environment

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Outline

- ❖ Introduction
- ❖ Open Geospatial Consortium (OGC) Web Services
- ❖ Geospatial Grid Services
- ❖ Abstract Model and Grid Services Workflow
- ❖ System Architecture of Geospatial Grid Framework
- ❖ Testbed and System Implementation
- ❖ Conclusion
- ❖ Future Vision



Introduction

- ❖ This research is funded by NASA AIST (AIST-02-0160) with the title “Integration of Grid and OGC Technologies for Earth Science Modeling and Applications”. PI is **Dr. Liping Di**.
- ❖ Making NASA EOSDIS data easily accessible to Earth science modeling and applications communities by combining the advantages of both OGC and Grid technology.
- ❖ Making Grid technology geospatial enabled and OGC standards compliant and making OGC technology Grid enabled.
- ❖ Allowing researchers to focus on science and not issues with computing, storage and bandwidth resources, as well as data receipt, data format and data set manipulation.

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Introduction (Cont.)

- ❖ The project has two major work items:
 - 1) Enable to access real data in the Grid environment with OGC protocols.
 - 2) Study the approach for geospatial product virtualization in the Grid environment and develop a prototype.
- ❖ Try to establish a service-oriented geospatial standard-compliant Grid framework for users to build up their specific application abstract model, execute it and get back their desired data products virtually through utilizing the OGC standard services and data and computing resources provided by Grid technologies.



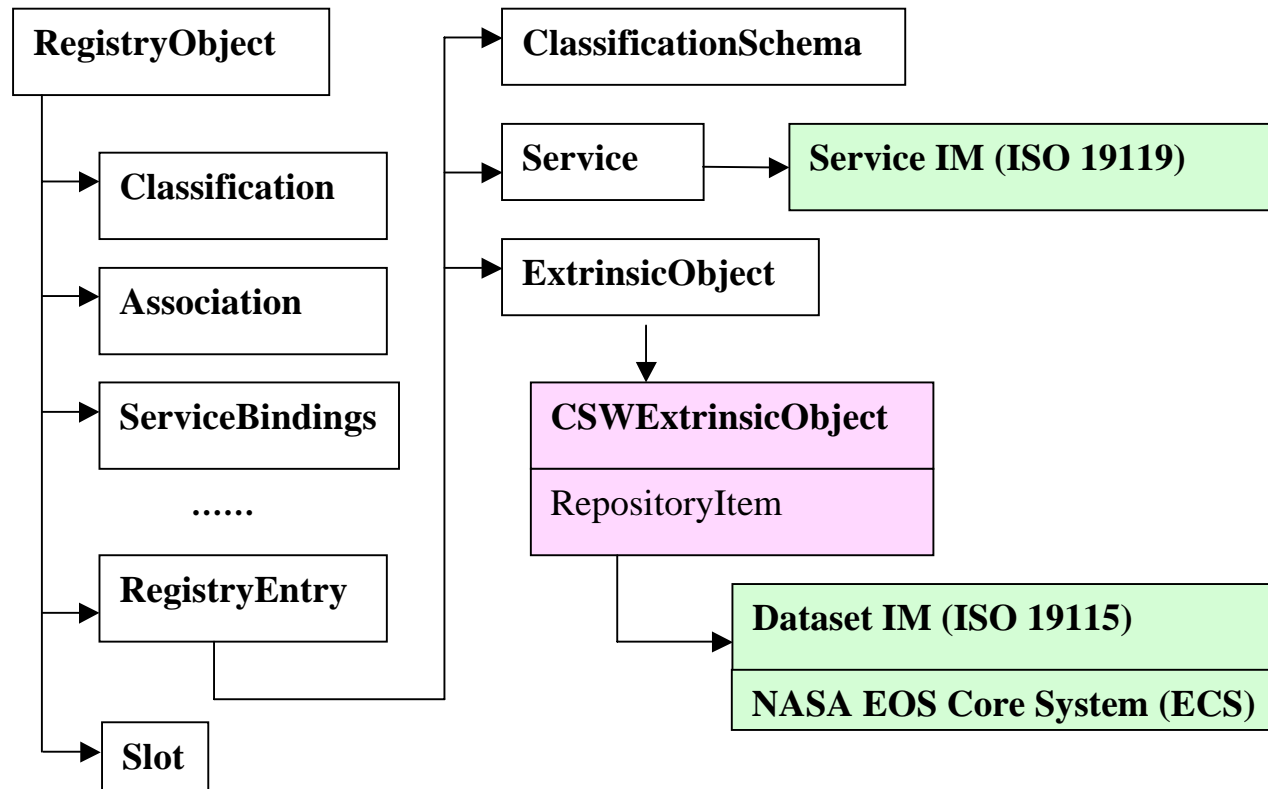
The OGC Web Services

- ❖ The Web Coverage Services (WCS) specification: defines the standard interfaces between web-based clients and servers for accessing coverage data.
 - All imagery type of remote sensing data is coverage data.
- ❖ The Web Feature Services (WFS) specification: defines the standard interfaces between web-based clients and servers for accessing feature-based geospatial data.
 - vector and point data are feature data.
- ❖ The Web Map Services (WMS) specification: define the standard interfaces for accessing and assembling maps from multiple servers.
 - visualization of geospatial data
- ❖ The Catalog Services for Web (CS/W) specification: defines the interfaces between web-based clients and servers for finding the required data or services from registries. It's based on the ebRIM.
- ❖ WCS, WMS, CSW, and WFS form the foundation for the interoperable geospatial data access and service environment.
- ❖ The Grid-enabled standard Portals for the above OGC services.



Design of the Information Model (IM) of CS/W

Extension of OGC CS/W for geospatial resources



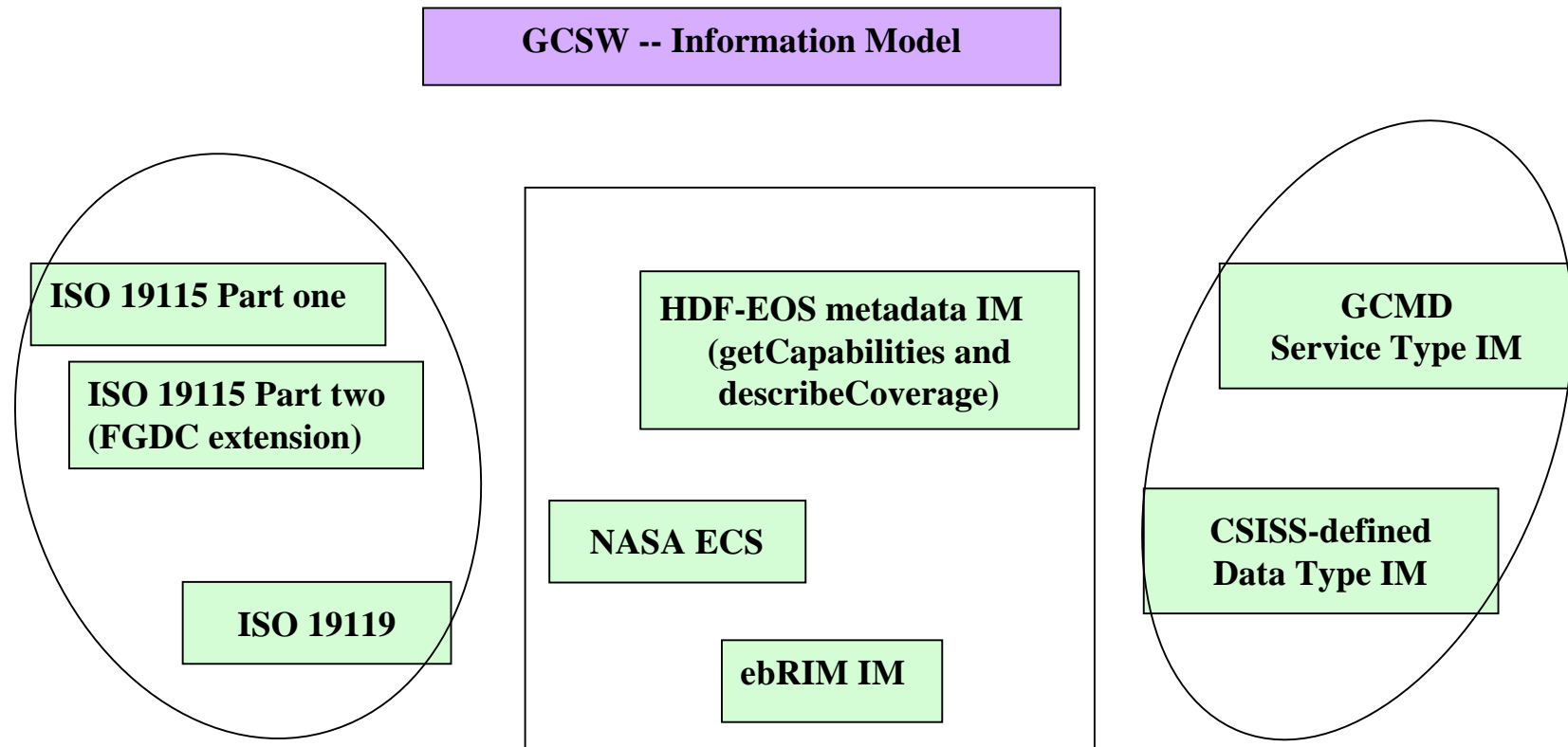
ebRIM + OGC Catalogue Service for Web + OGC Catalogue Service for ISO 19115/19119

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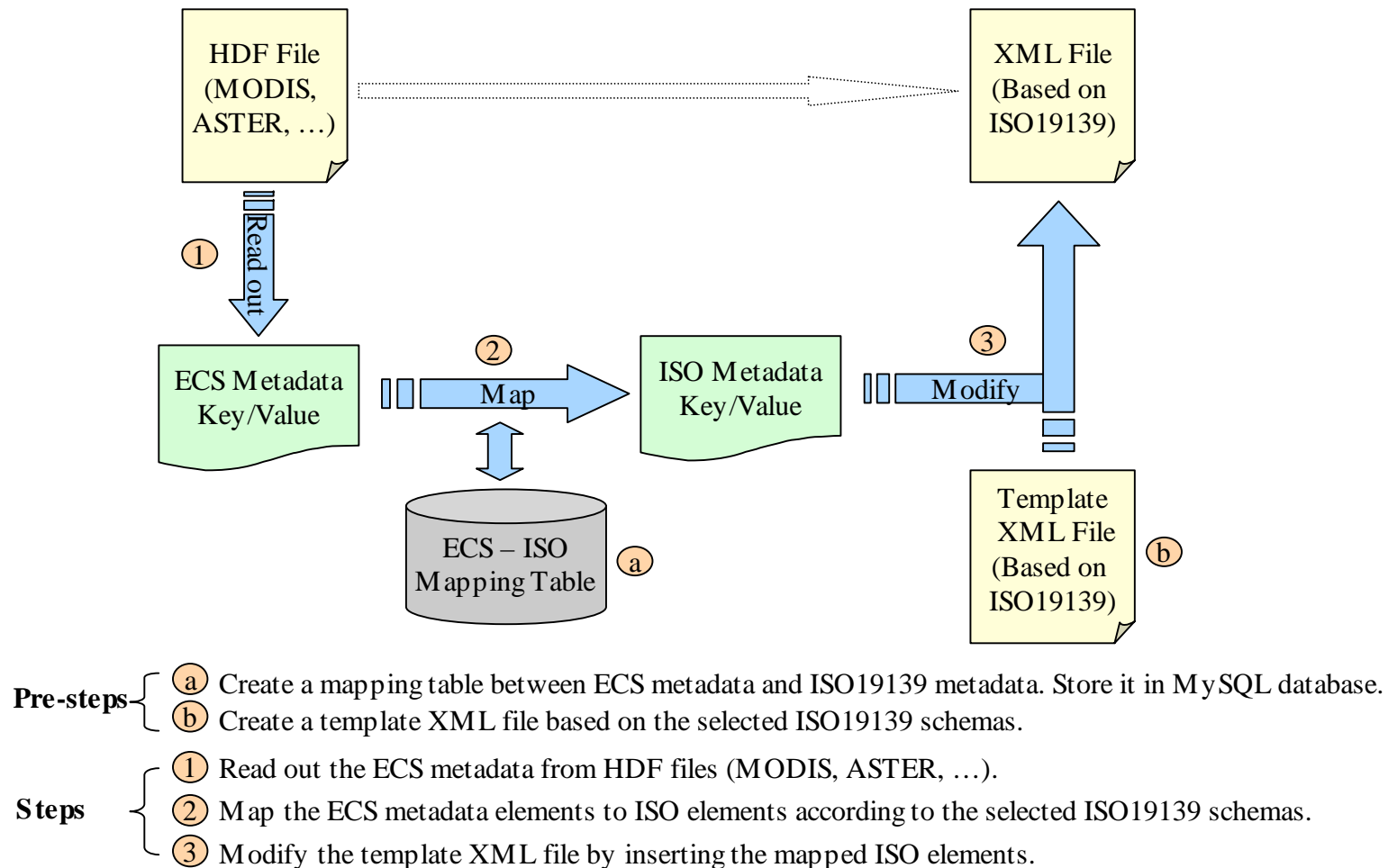
Software Development for Integration - GCS/W

- ❖ Designed and implemented Grid-enabled OGC Catalog Service for Web





Design of Data Registration of CS/W



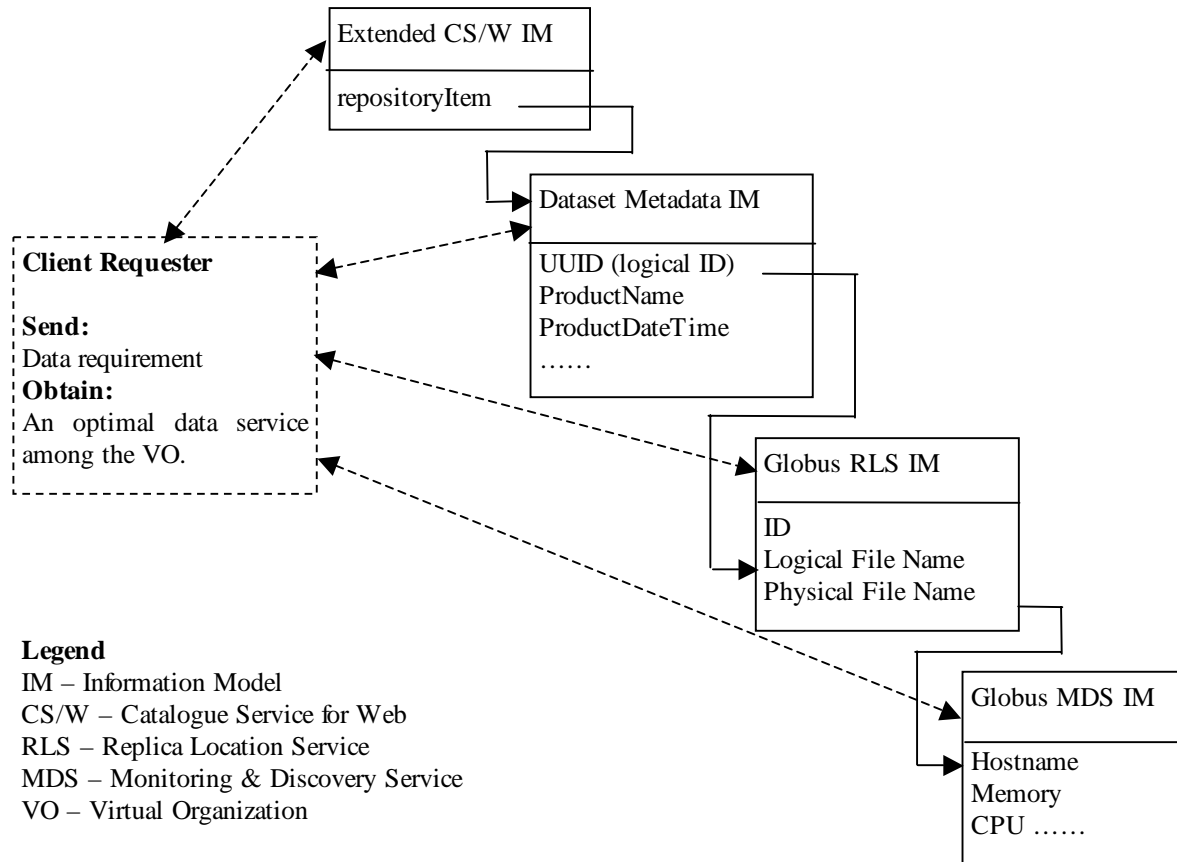


Geospatial Grid Services and other Grid services

- ❖ Grid-enabled Catalog Service for Web (GCS/W)
- ❖ Grid-enabled Catalog Service Federation (GCSF)
- ❖ Grid-enabled Web Coverage Service (GWCS)
- ❖ Grid-enabled Web Map Service (GWMS)
- ❖ Intelligent Grid Service Mediator (iGSM)
- ❖ Replica and Optimization Service (ROS)
- ❖ Data Transfer Service (DTS)
- ❖ BPEL-compliant Grid INstantiation Service(GINS)
- ❖ BPEL-compliant Grid Workflow Engine Service (GWES)
- ❖ Other Grid Services for application



Grid Enabled Catalogue Service for Web (GCS/W)

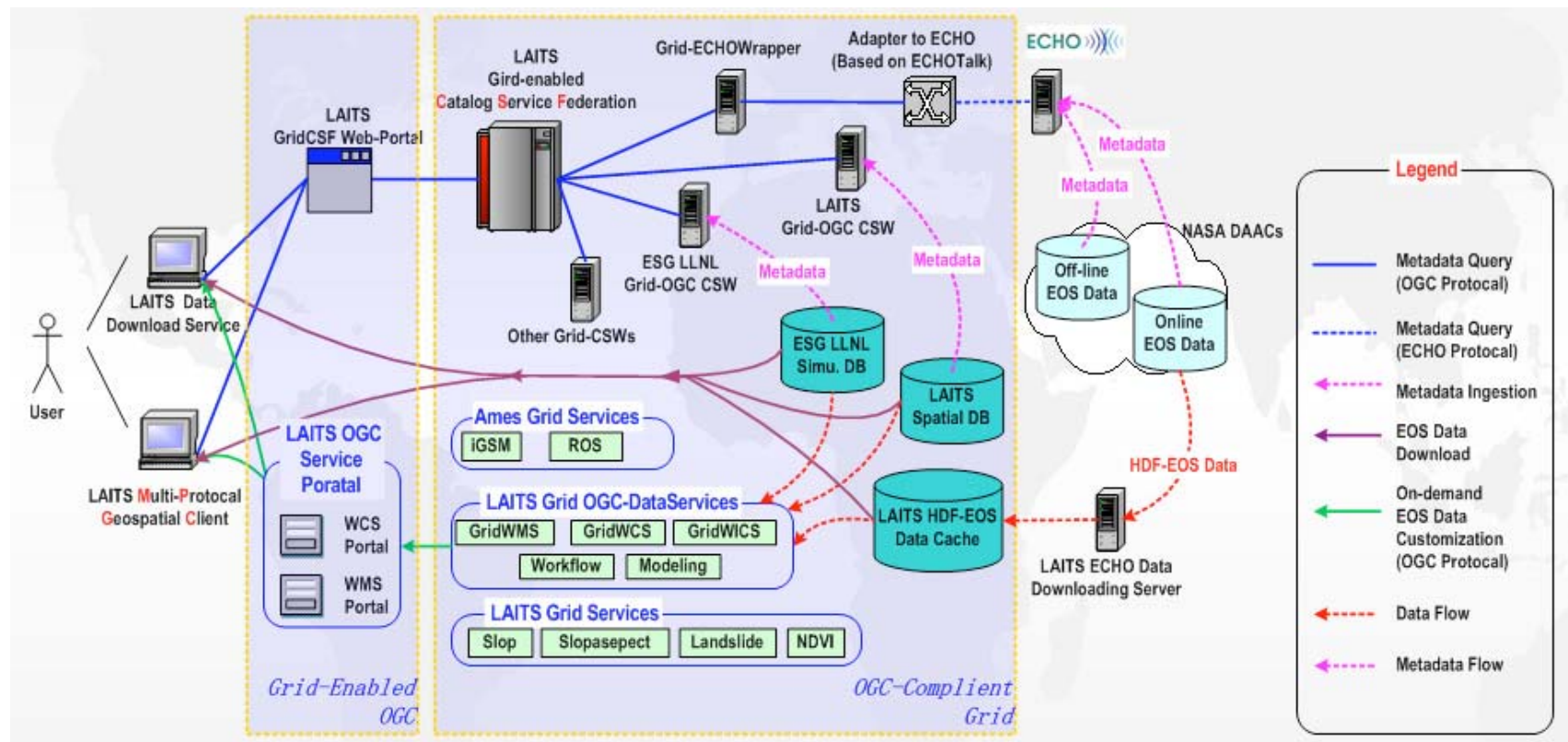


Integration of Information Model of CS/W and Grid RLS/MDS



Software Development for Integration - GCSF

- ❖ GCSF harmonizes user query among GMU CSW, ESG CS and ECHO.
 - Talked with NASA ECHO through GMU GCSF.



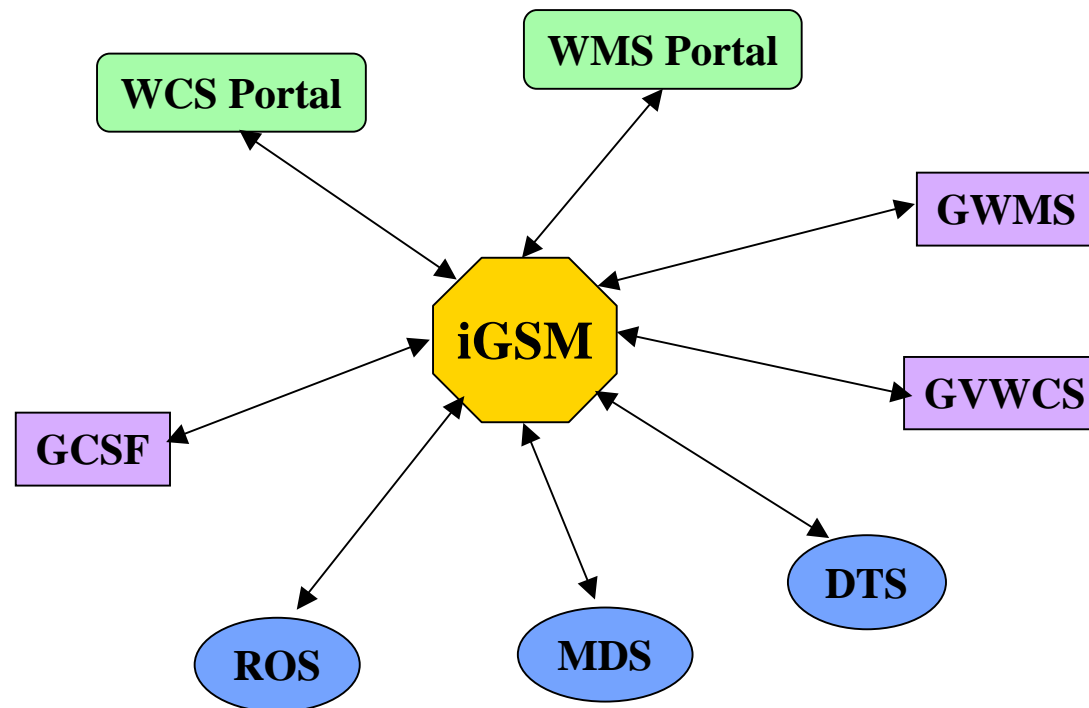
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Intelligent Grid Service Mediator (iGSM)

(iGSM: intelligent Grid Service Mediator)

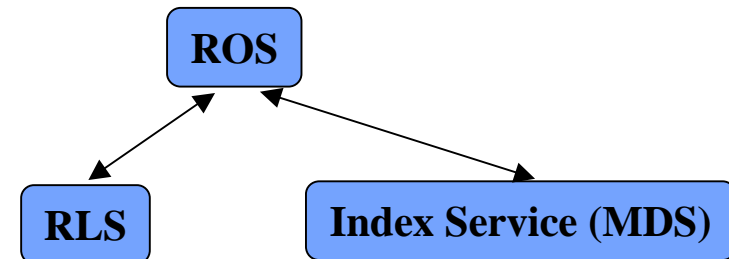
- ❖ Support WCS portal, WMS portal and Grid Virtual WCS to distribute their request to proper GWCS and GWMS.



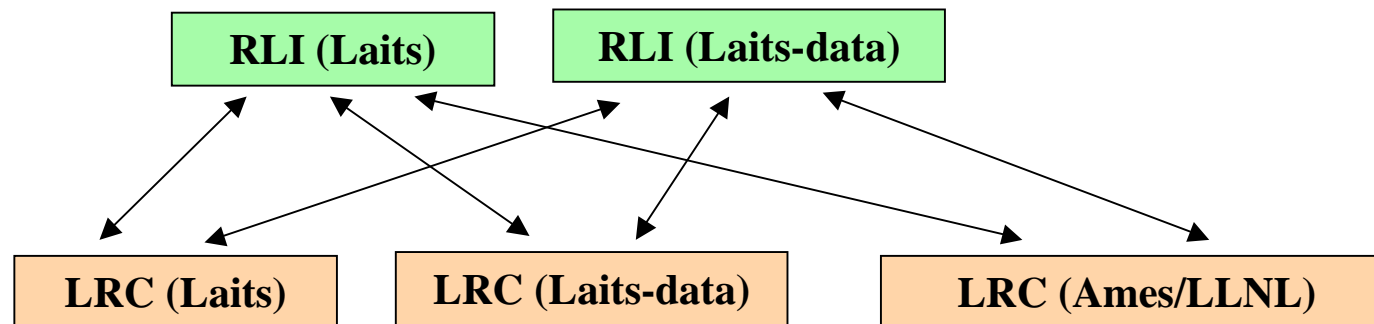


Replica and Optimization Service

❖ Replica and Optimization Service (ROS)



❖ Globus RLS as Grid Service



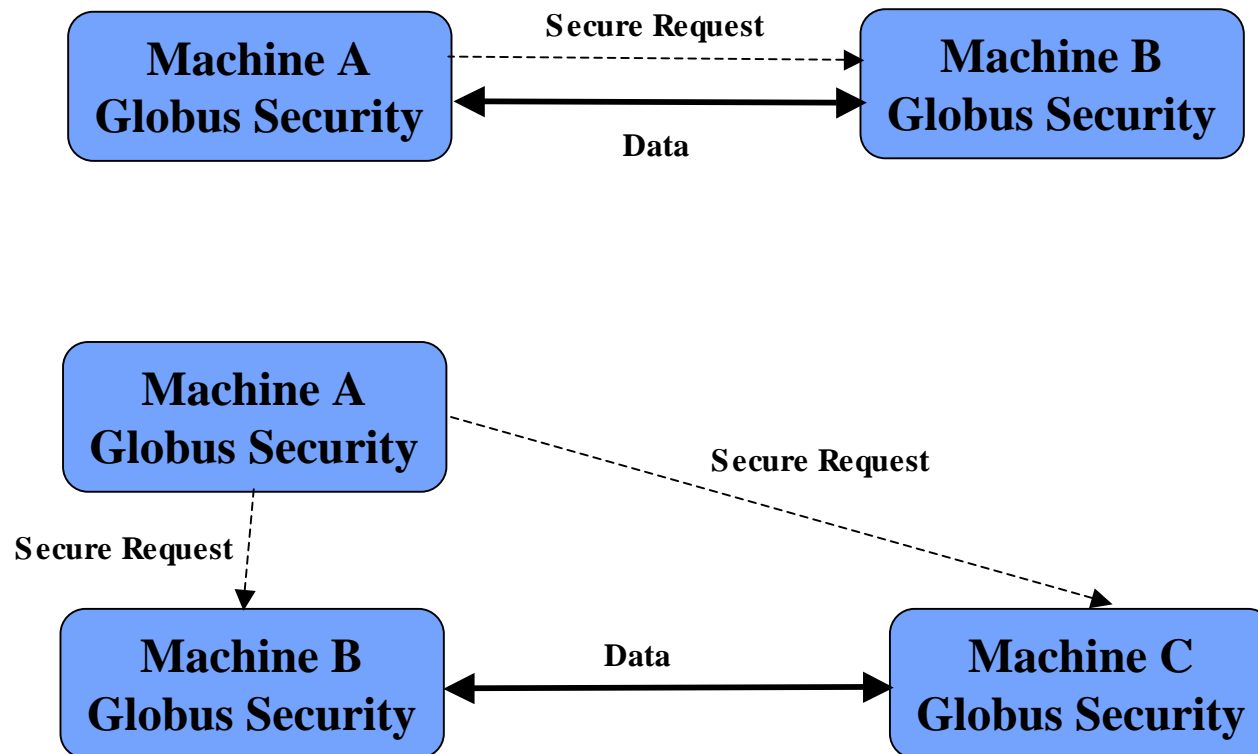
❖ Globus Index service

❖ Globus MDS scripts modification



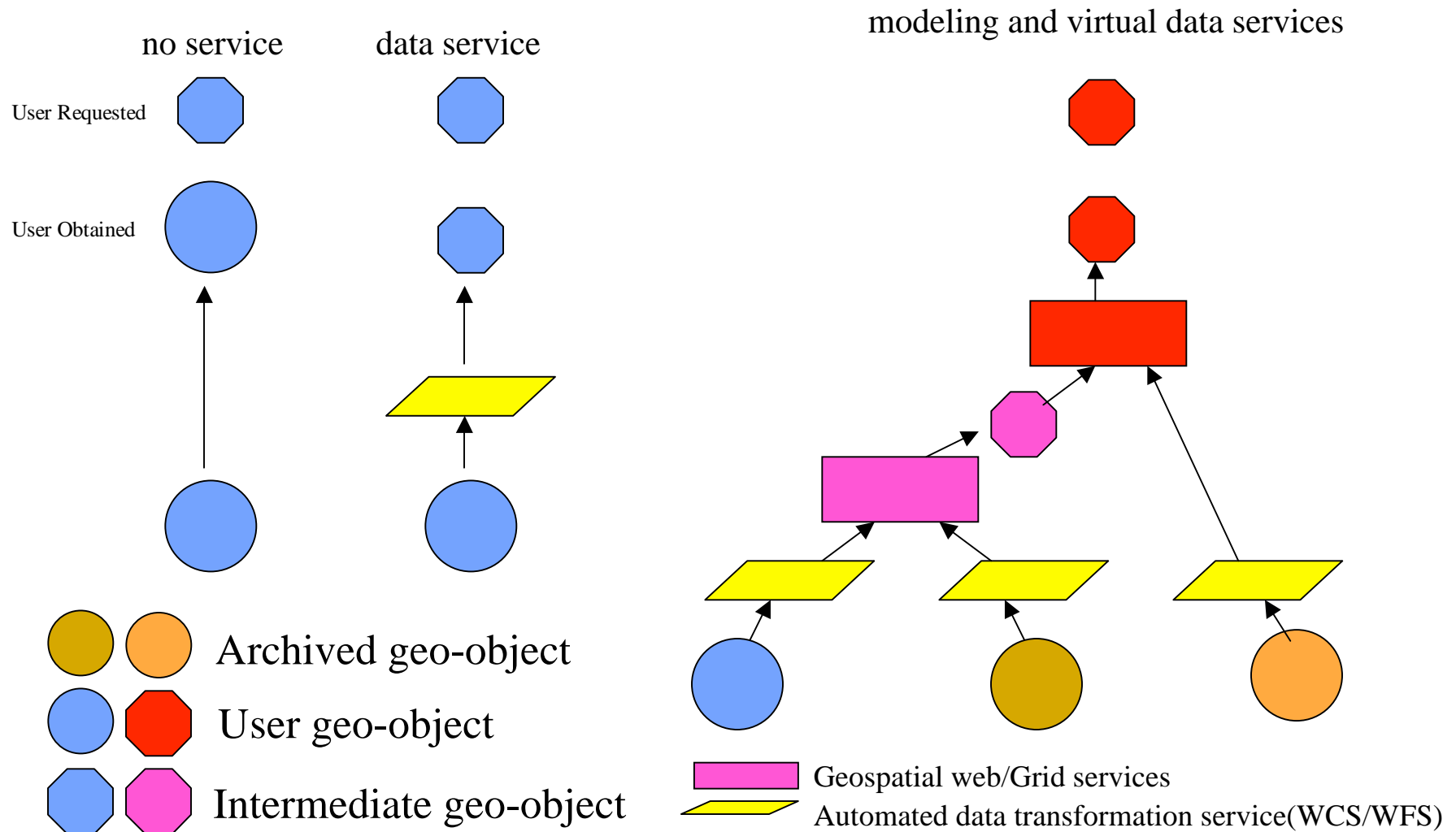
Data Transfer Service

❖ Data Transfer Service (DTS) based on GridFTP as Grid Service





Concept Models of Virtual Data Products (VDP)



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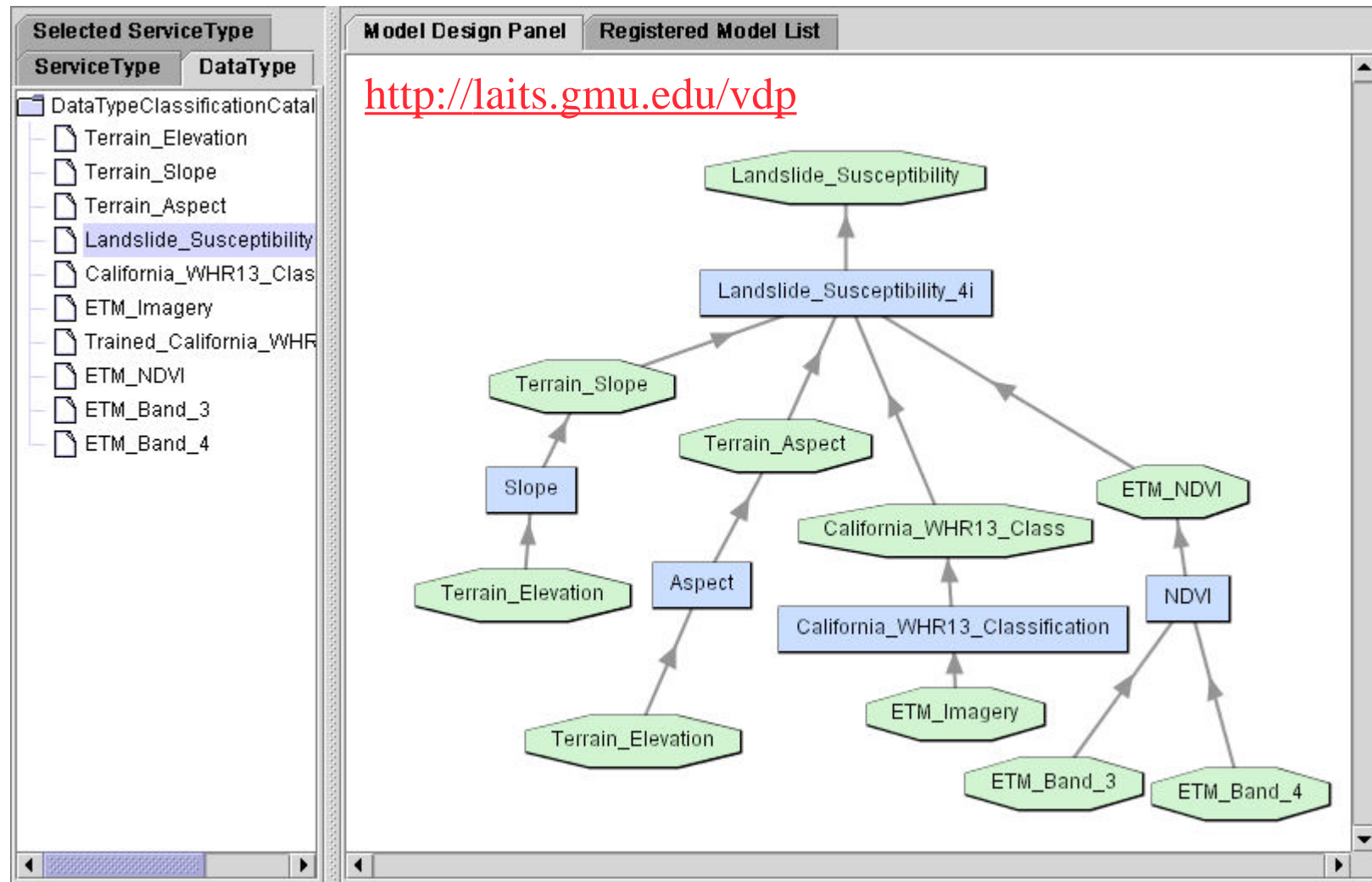
- **DTC**: Data Type Catalogue. Data are classified into type based on their scientific meaning. e.g. DEM, Slope, SlopeAspect, Landslide etc.
- **STC**: Service Type Catalogue. Services are classified into service types based on their scientific meanings. e.g. DEM2Slope, DEM2SlopeAspect, SlopeAspect2Landslide, DEM2Landslide etc.





Building up Virtual Data Products

❖ Abstract Model based User interface for modeling VDP





Registry of Abstract Model of VDP

❖ Registration of Abstract Model to GridCSW

The image displays three overlapping screenshots of the 'Model Registration Wizard Dialog' interface, illustrating the steps for registering an abstract model to GridCSW.

Step 1: Name and Description

- Model Name:** Landslide_2i_model
- Model Description:** Landslide model with two inputs
- Navigation:** Back button

Step 2: Applicable Spatial Range

- Projection:** EPSG:4326
- North:** 45.0
- East:** 60.0
- South:** 10.0
- West:** 30.0
- Navigation:** Back, Next buttons

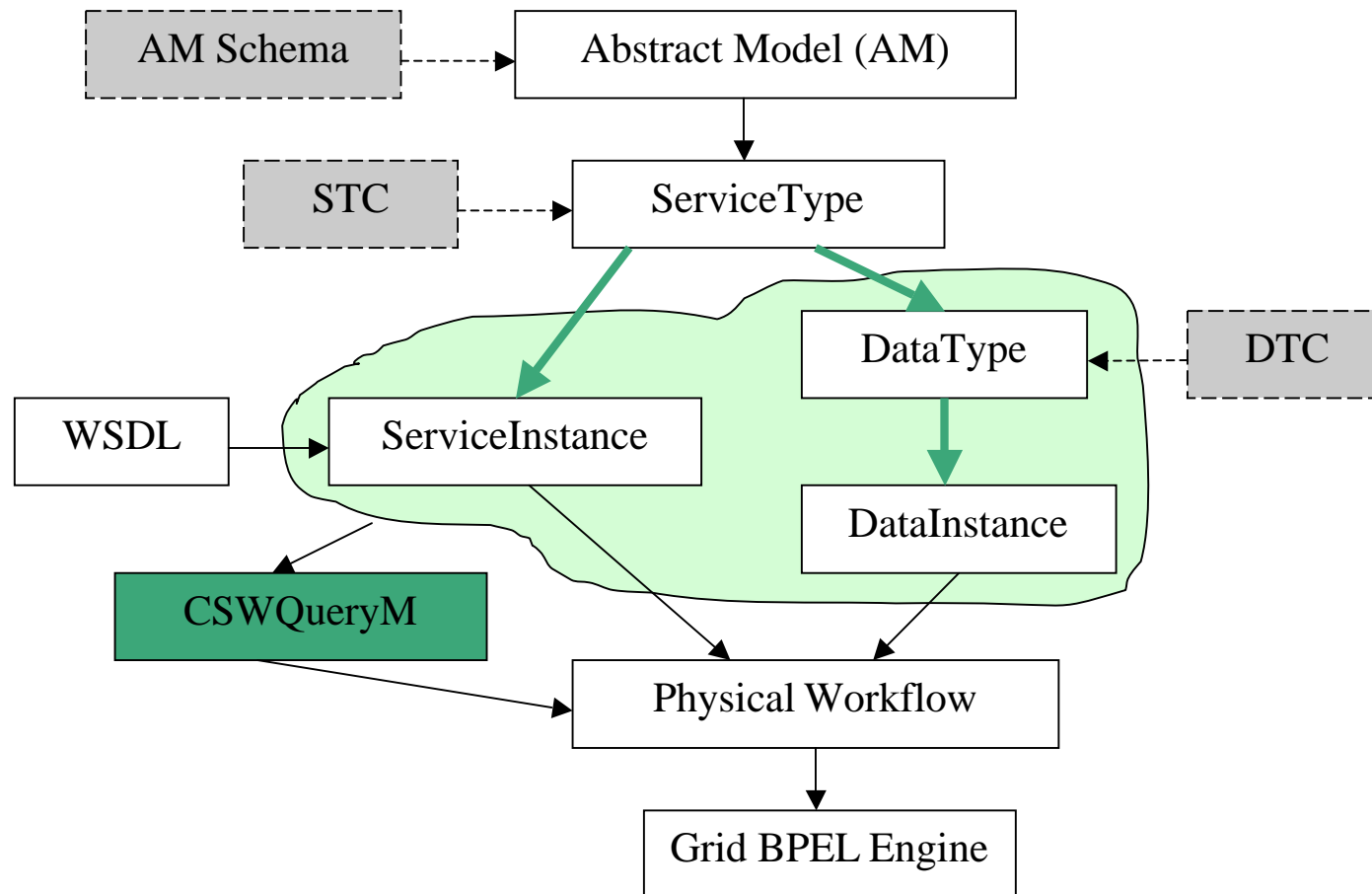
Step 3: Specify Model Keywords

- Keywords:** landslide (Seperate with ",")
- ECSDisciplineKeyword:** EarthScience
- ECSTopicKeyword:** Radiance or Imagery
- ECSParameterKeyword:** Infrared
- ECSVariableKeyword:** Infrared Imagery
- ECSTernKeyword:** Infrared Wavelengths
- Navigation:** Back, Register, Cancel buttons



BPEL-compliant Grid Instantiation Service(GINS)

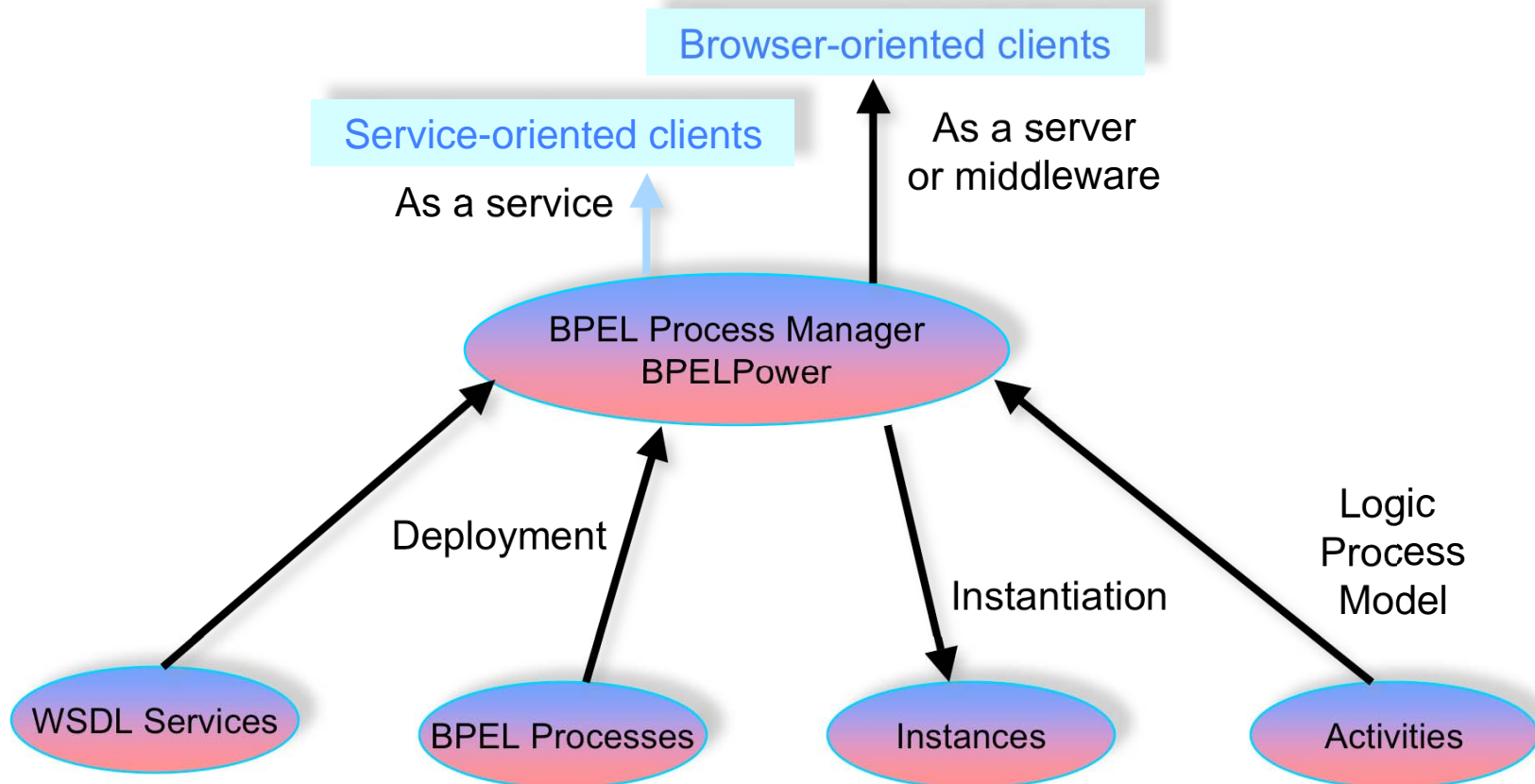
❖ Instantiation of the Abstract Model to the Concrete Workflow





Design BPEL-compliant Grid Workflow Engine Service (GWES)

- ❖ BPEL engine architecture – Execute Grid Services with Standard BPEL workflows.





BPEL-compliant Workflow Engine for Grid Services

BPEL Process Manager - BPELPower - Mozilla Firefox

EN English (United States)

File Edit View Go Bookmarks Tools Help

http://laits.gmu.edu:8098/bpelgrid1/admin/ngServices.jsp?name=service&idNS=http://laits.gmu.edu/GridWCS/service&idName=C

Getting Started Latest Headlines

Gmail - Inbox ESTC 2006 -- Sessions BPEL Process Manager - BPELPower

GridBPEL Engine for Grid Services

Support | About Project Group

WSDL Services BPEL Processes Instances LBPL Activities

Deployed WSDL Services

Service Name	Service Name
GridLandslide2Service	GridSlopeAspectService
GridSlopeService	GridVWCSService
GridWCSService	GridWCTService
GridWICService	

Deploy New Services Undeploy Services Sort Services

Service Management

Execute a Business Service. Selected service is **GridWCSService**. Selected port is **GridWCSPortTypePort**. Selected operation is **getCoverage**. Please input value.

Initiate Debug WSDL XPATH

getCoverage parameters

```
getCoverage
{
    string version =
    string coverage =
    anyURI crs =
    string bbox =
    string format =
    int width =
    int height =
    float resx =
    float resy =
    string axisname =
    string axisvalue =
}
```

Execute the service

Done

start BPEL Process M... 2006_Doc Eudora - [In] 3 Microsoft Po... Di-ESTC_Grid-P... Adobe Photoshop 11:48 AM



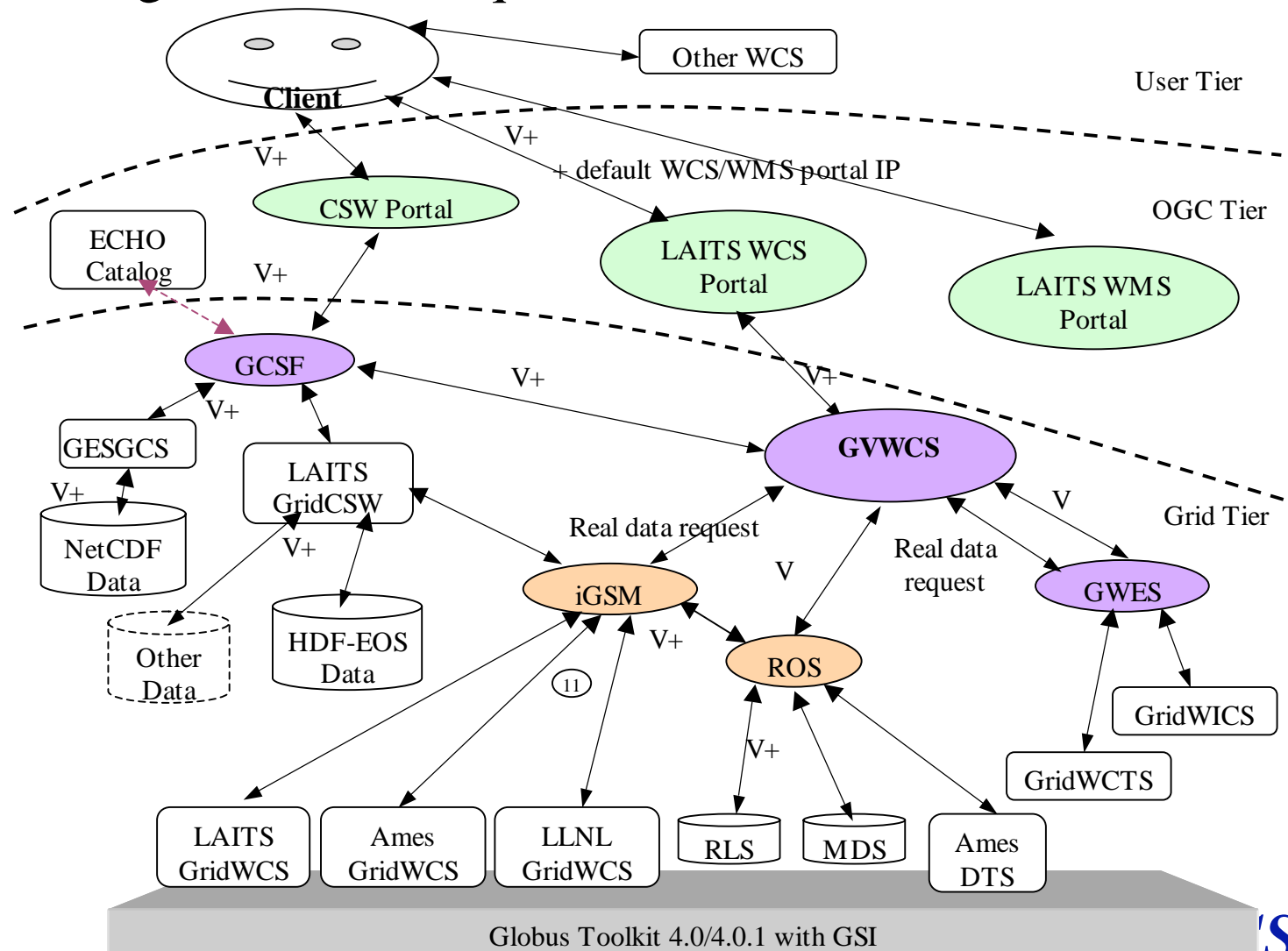
Grid Services for Materialization of VDP

- ❖ Existed Geospatial Grid services for modeling VDP
 - GWCS; GWMS
 - GCS/W; GCSF
 - GWICS (Grid-enabled WICS)
 - GWCTS (Grid-enabled WCTS)
- ❖ Other Grid Services
 - iGSM; ROS; DTS, GINS, GWES
- ❖ For the prototype demonstration of VDP, additional Grid service instances have been developed
 - GridSlope
 - GridAspect
 - GridCalifornia_WHR3_Classification
 - GridNDVI
 - GridLandslide_Susceptibility_2i
 - GridLandslide_Susceptibility_4i



System Architecture of Geospatial Grid Framework

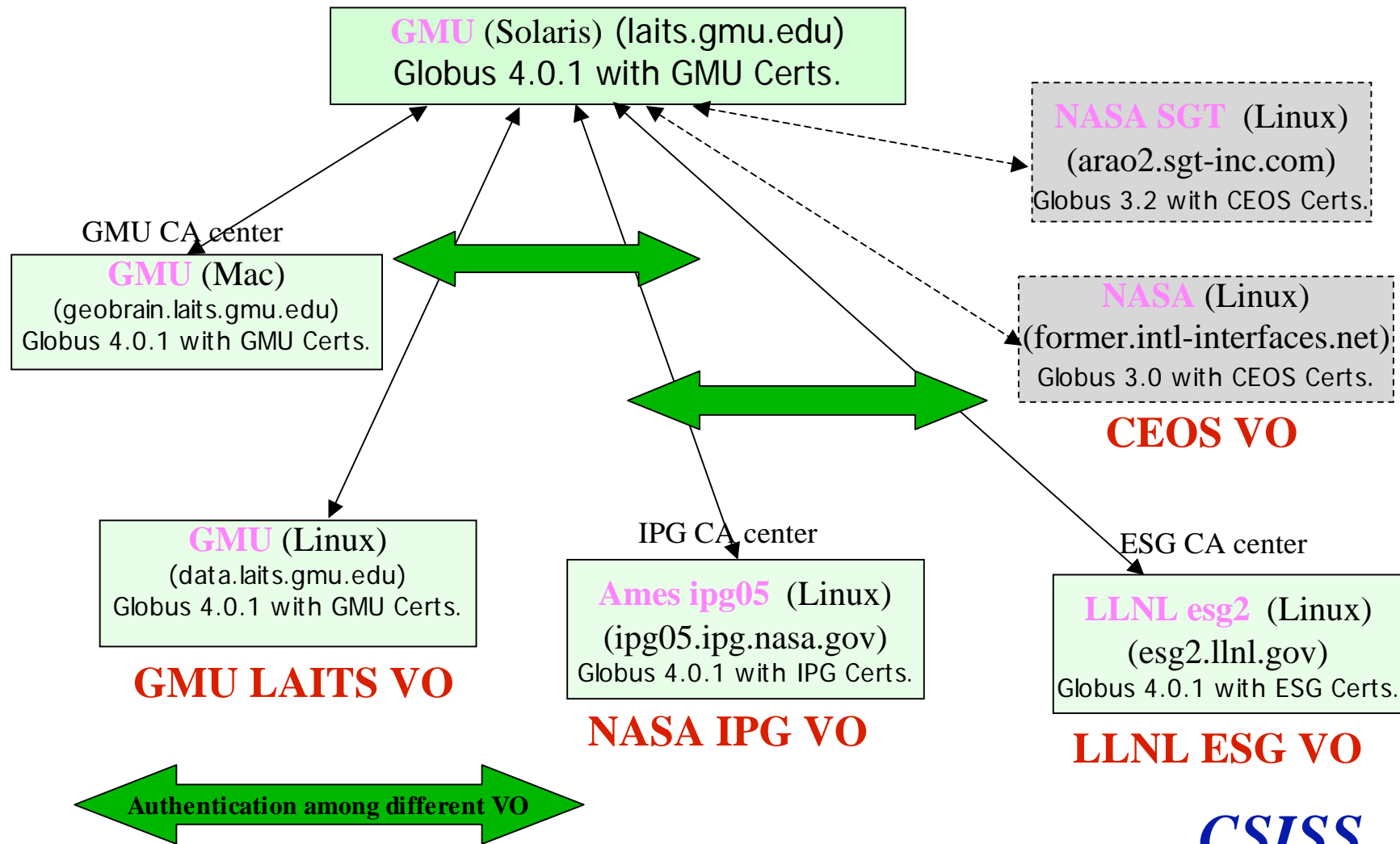
❖ Diagram of user request and data workflow





Implementation: Testbed

❖ Grid Security (GSI) and VO Setup



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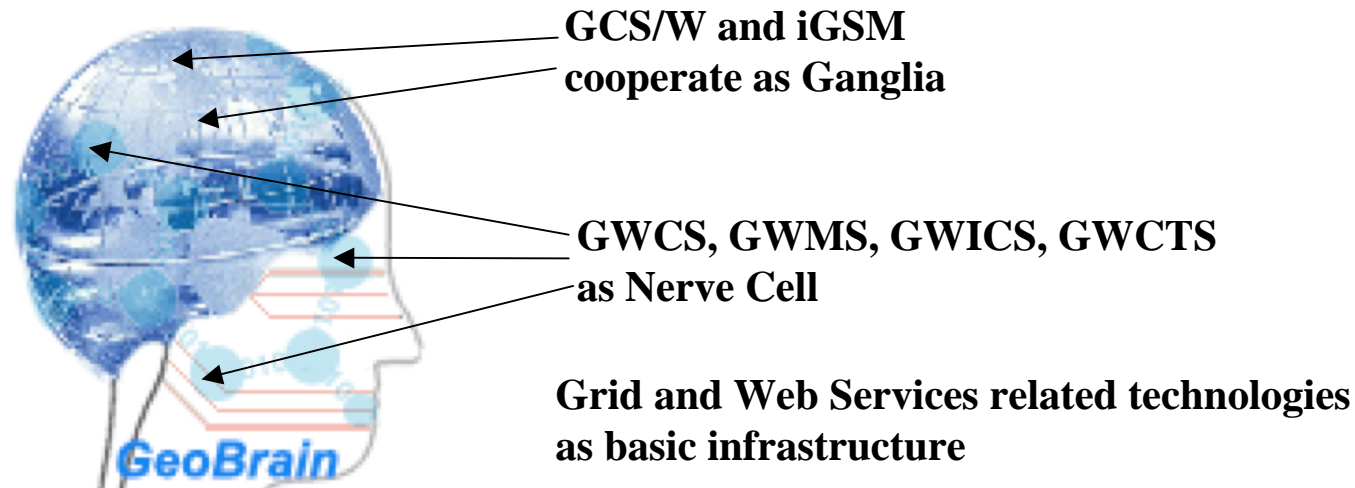


Conclusion

- ❖ The Grid service-oriented approach to serving geospatial data is a promising strategy for establishing an open, wide and secure system that securely provides access to huge volumes of distributed geospatial data/information through querying geospatial catalogs.
- ❖ Devised a new geospatial abstract information model for virtually building up geospatial application abstract model.
- ❖ Implemented a BPEL-compliant Grid service workflow engine for executing concrete workflow which is expressed in standard BPEL.
- ❖ Applied the abstract model to Grid environment and concrete it to Grid-service workflow and execute it with Grid Workflow Engine.
- ❖ Implements a prototype system that demos a landslide virtual data products.



Future Vision



- ❖ Building up abstract model to produce virtual data products when user request it.
- ❖ Using ontology-based semantic solution to provide automatically users application modeling
- ❖ More Cell and more powerful Ganglia will be developed for more easily and completely Earth Science Data obtainments.
- ❖ More specific Ganglia and Cell will be provided for special domain user requirements.



Thank You !

Any Questions ?

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